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AUTHOR Hummel, Thomas J.
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ABSTRACT

This document discusses the creation of a new formal language for the field of counseling psychology. Constructs for such a language are applied specifically to the communication of research information (especially research concerned with the effects of counselor action on clients) for experimental replication. Grammatical concepts of a formal language are described, i.e., syntactic categories (called nonterminal symbols), terminal symbols of the language (English words), and rewrite rules for combining symbols into strings (such as sentences). An argument is made for the use of a computer language as the vehicle for communicating explicit information about counseling actions, and examples of possible rewrite rules for counseling language are given. A strategy is presented to translate counseling language into a form recognizable by a computer, using an "interpreter," i.e., a computer program which would interpret the counseling language. The tasks of the interpreter are described, and the design of the interpreter program is discussed. Tables are given which provide examples of input to the interpreter. (WAS)

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Communicating Counseling Research Using Formal English and Computer Models

by

Thomas J. Hummel
University of Minnesota

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INTRODUCTORY REMARKS

Statements by Karl Pribram in his "Languages of the Brain"(1971) aptly set the general context for this paper:

"I recently attended a meeting of psychologists who addressed the problem of human learning. Animal psychologists, SR psychologists, social psychologists, educational psychologists, mathematical psychologists, cognitive psychologists, psycholinguists, and psychophysiologists all had their say. As I was to summarize the contents of the conference, I listened carefully for commonalities among the welter of presented material. A restricted number of problem areas was being explored, but a rich diversity of terms confused and blocked communication among the separate factions of psychologists and resulted in a profusion of tongues.... The variety of linguistic subcultures resulted more from the variety in the actions taken to resolve the problems than from variety in the problems per se. Thus the conference on human learning proved a microcosm of human learning, a study of how an elite of talking animals uses the linguistic tool..." (p.325) "the...compulsion to generate languages... both creates the disparate tongues that make the intellectual community a present-day Tower of Babel and provides the means to transcend it."(p.xi)

Social, cognitive, SR and even linguistic approaches are all to be found within the subfield of Counseling Psychology, resulting, on a smaller scale, in an analogous profusion of tongues and terminologies. If we believe Pribram, then one solution to our counseling language problems may lie in the creation of a new language.

The present paper is limited to one aspect of the communication problem in counseling psychology, focusing on an approach to resolving some of the difficulties inherent in communicating certain types of research from one institution to another. Specifically, it is concerned with the replication by one institution of research carried out at another. Of primary interest is research concerned with the effects of counselor actions on clients, particularly those effects which are testable using randomized comparative experiments.

In general, it is not difficult to communicate some aspects of this type of experiment. The experimental design, or layout, for example, can usually be replicated with relative ease, and the data can be analyzed using either the same computer program or one known to produce identical results. In the event no computer program were to be available, the institution originating the research can send a copy of the program, permitting anyone able to read the program to see exactly how the computations were carried out. Problems arise, however, when it is necessary to recreate specific counselor actions in exactly the same manner as in the original experiment. No set of explicit instructions, as with a computer program for data analysis, is available. For example, the procedure for "interpreting" a client statement has neither the widely agreed upon meaning nor the explicitness of action associated with, say, carrying out an analysis of variance on a particular set of data.

The ideas presented below would address problems of disparate terminologies and approaches through the development of a formal language. This formal language would describe counselor acts in such a way as to remove the ambiguities inherent in natural languages. In attempting to create a new language one cannot, of course, be certain that a solution is being offered, and not another part of the problem.

FORMAL LANGUAGE

According to Barr and Feigenbaum(1981), "Formal Language is defined as a (possibly infinite) set of strings of finite length formed from a finite vocabulary of symbols. (E.g., the strings might be sentences composed of a vocabulary of words.) The grammar of a formal language is specified in terms of the following concepts"(p. 239).

1) Syntactic categories (referred to as nonterminal symbols or variables, e.g., SENTENCE, AGENT, ACTION).

2) "Terminal symbols of the language, e.g., words, in English. The terminal symbols are concatenated into strings called sentences (if the terminals are words). The language is then just a subset of the set of all the strings that can be formed by combining the terminal symbols in all possible ways. Exactly which subset is permitted in the language is specified by the rewrite rules ... "(Barr and Feigenbaum,1981, p. 239).

3) Rewrite rules for combining symbols into strings. These specify the relations between certain strings of terminal and nonterminal symbols. For example, the rules could allow the string "the counselor reflected the feeling", but not allow "reflected counselor the the feeling". Table 1 contains several examples of rewrite rules for a "counseling language" and some of the sentences they generate.

The utility of this formal approach to language lies in the fact that the language depends on a pre-declared set of words which can be formed into a pre-defined set of sentence types. This can result in a fragment of English to use in a particular situation for a particular purpose, such as describing the actions of a counselor. In using a formal language, one can reduce the problems of disparate terminologies and the ambiguities of natural language whereby a term can have several different meanings. In providing a limited, more formal structure, we enhance the probabilities that the meaning can be transferred intact across time and situational boundaries. At the same time, if a new word or sentence type is required to communicate an idea previously incapable of expression, there is the freedom to add the necessary elements to the language.

The consideration of the details of a formal counseling language might most logically begin with imagining a counselor interviewing a client. To represent all of the counselor's knowledge at the outset of the interview would, of course, be virtually impossible. We could, however, represent that subset of the knowledge required to carry out the interview. This subset of knowledge, bound by the conditions of a particular situation, is designated here a "microworld" (Papert,1980), i.e., that subset of a counselor's world knowledge relevant to the interview at hand. For the purposes of our formal language development, we will only need to

represent that knowledge which is unique to this interview. We have no need to attempt a representation of the " common knowledge" which the counselor shares with other normal adults.

If the language is to aid in communicating explicit information about a counselor's performance knowledge (i.e., "how to" or procedural knowledge [Anderson, 1976]), then the language will have to represent actions at the level of simple operations, operations which could be carried out precisely by those who would replicate the counselor's behavior. In addition, it would be important to represent the goals, strategies and tactics which help to specify the conditions under which particular actions should be taken. In earlier papers, a case has been made for developing counselor algorithms which embody the required specificity and conditionality. (Hummel, 1976; Shaffer and Hummel, 1979)

Complete models of formal languages using algorithms are found in computer languages. In the context of the machines on which they operate, computer programming languages are free of ambiguity. Meaning is attributed to the language through an understanding of the operations to be carried out when a sequence of "sentences" comprising a computer program is executed on a machine. A computer language could serve as the vehicle for communicating explicit information about counseling actions. Existing computer languages, however, while suitable for the translation of mathematical formulas or the processing of data structures such as lists, might be too abstract to communicate human behaviors easily, especially for inexperienced users. One can, however, conceptualize a computer language based on a formalized subset of English which could communicate unambiguous specifications of counselor actions, even to nonprogrammers.

As stated above, a programming language to communicate counselor actions should not be expected to allow for a complete representation of the totality a human counselor's knowledge. We could, however, communicate a subset of that knowledge with enough clarity of specification to increase consistency from counselor to counselor with respect to what actions are to be performed and under what conditions. We know from experience that we can achieve highly consistent behavior across individuals by providing, say, good directions for arriving at a destination or well structured

procedures for solving, say, a mathematical problem. In a recent paper on the acquisition of cognitive skills, J.R. Anderson (1982) presents a theory which explains in part how individuals make the translation from written directions to actual performance, and the work of L.N. Landa (1974) has advanced our knowledge of the art of developing complete prescriptions for carrying out complex actions.

The counselor's actions can be defined as operations which result in changes in the counselor's cognitive representation, i.e., the microworld, particularly the image of the client. Understanding counselor behavior in terms of these concepts of representation and action is analogous to the way that computer "behavior" is often understood. In a computer program, actions can also be viewed as a change in the representation, i.e.,the contents of memory locations. Suppose that we have the following variable assignments: x:= 7 and y:= 6. If these two statements are followed by z:= x + y and WRITE(x,y,z), we could expect to see the contents of x, y and z printed on, say, our monitor, as the numbers 6, 7 and 13. The symbols ":=,+," and "WRITE," specifify the actions "assign," "add" and "write to an output file," respectively. In using computers, we do not actually observe the electronics perform the arithmetic or memory reads and writes, but since we understand the acts (i.e., can simulate them ourselves in some fashion) and can verify that the representation has changed, we correctly infer that the act has been carried out. In a similar manner, if counselor actions are broken down into elementary operations which change the representation in ways we can easily mentally simulate, then we have an understanding of the behavior.

Having a formal counseling language in which the actions would be executable by a computer provides the means for simulating the dynamics of an interaction and optimizing the benefits of using a formal language. Programs in the counseling language could be developed for demonstrating procedures and teaching them to people so that training could be duplicated across institutions. Inthe context of experiments carried out to assess the effect of a counseling intervention, a "counseling program" would provide a structure which could be used by an investigator to describe a counselor's knowledge base and to prescribe particular actions and

the impact of those actions on the defined world of a particular counselor interaction. At another time and place, an investigator wishing to replicate the experiment could have counselors mimic the working model provided by the computer program. Successful mimicry could provide a check on the ability to perform, going beyond the ability to conceptualize actions based on reading a typical page of text.

TABLE 1

Examples of Possible Rewrite Rules
for Counseling Language

1. SENTENCE-->the HUMAN-OBJECT is EMOTIONAL-STATE.*

2. SENTENCE-->the AGENT COMMUNICATION-ACTION that the HUMAN-OBJECT is EMOTIONAL-STATE.

3. HUMAN-OBJECT-->husband,wife;

4. EMOTIONAL-STATE-->angry,anxious frustrated,all-wound-up-inside;

5. AGENT--> counselor,co-counselor;

6. COMMUNICATION-ACTION--> restates, reflects, clarifies;

These rewrite rules, or productions, are applied successively, for example:

By Rule 1: SENTENCE--> the HUMAN-OBJECT is EMOTIONAL-STATE.

By Rule 3: the husband is EMOTIONAL-STATE

By Rule 4: the husband is angry.

The six rules generate 58 sentences, for example:

The wife is anxious.

The counselor restates that the wife is all-wound-up-inside.

The co-counselor reflects that the husband is frustrated.

* Upper case indicates non-terminal symbols (variables), and lower case indicates terminal symbols.

THE INTERPRETER

A counseling language which will run on a computer will need to be translated into a form which is recognizable to the machine. The strategy presented here involves developing an "interpreter" for the counseling language. As defined by Winston(1977), "An interpreter is a program that effects the processes described in the user language by interleaving program examination and process performance steps (p.361), and later, "interpretation is that process by which algorithms are executed by continual inspection of user programs written to describe them." (p.371) For present purposes, the "user language" is the formal counseling language, and "user programs" written in the language will be comprised of productions, i.e., "if condition A is true, then carry out action B." This is the same type of situation-action rule used above for reprensenting an example of formal language syntax.

To help in describing the tasks the interpreter must perform, Tables 2.1, 2.2, and 2.3 present examples of input to the interpreter. Each is discussed in turn in the following paragraphs.

Table 2.1 presents examples of generic facts about the counseling microworld. The examples are of the kind of counselor knowledge which would exist before actually seeing and interacting with a specific client. This input to the interpreter would define and delimit the context for a particular interaction, containing information about the general counseling situation, such as typical configurations of objects, what attributes they have and what their typical states are. The same input would define relationships among various concepts, organizing them into structures such as sets, subsets, and fuzzy-sets. (Zadeh,1965)

In Table 2.1, the set of EMOTIONAL-STATES is presented as an example, including "angry", "anxious", etc. The fuzzy-set of ANXIETY-INDICATORS has as a member the affect phrase "all-would-up-inside" with a membership degree of .6 on a 0 to 1 scale. In a more extensive table, additional entries from, say, Davitz's(1969) "The Language of Emotion" would be included in the

sets and fuzzy-sets. Other structures might organize such factors as the counselor's as the counselor's background knowledge about say, "female clients," or "incest victims." Following the input of general information, one would have the option to include information specific to a particular client, such as might be aquired through intake procedures or from previous interviews.

Table 2.2 presents prescriptions for a defined set of actions which can be taken within the defined context or microworld. Three actions are presented: RESTATE, REFLECT, and CLARIFY. All three share the common goal of selecting an affect word or phrase the counselor might substitute in a response to the client taking the form "You feel (affect word or phrase) ... ." RESTATE simply selects the affect statement used in the client's previous statement and substitutes it verbatim in the counselor's response to the client. In contrast to this, REFLECT would attempt to use a word or phrase similar to that used by the client. To do this, the set of AFFECT-INDICATORs would be compared to the affect indicator just used by the client. A selection would be made on the basis of how similar an affect indicator was to the client's indicator in terms of the DIMENSIONS-OF-AFFECT-INDICATORS. These dimensions would characterize the affect indicators in terms, say, of how "visceral" the expression was or in terms of "tightness" or "explosiveness". Again, Davitz's(1969) work would be helpful here. If the most similar affect indicator were sufficiently similar to the client's words, i.e., the DEGREE-OF-SIMILARITY exceeded a predetermined SIMILARITY-STANDARD, then it would be used in the response to the client. Operationally, the similarity between two affect indicators could be computed by defining for each indicator a vector of indices which represents the degree to which the affect indicator "loads" on each dimension, i.e., "tightness", "explosiveness", etc., and then taking the inner product of the vectors as an index of similarity. There is precedence for such an approach in a current associative recall model (Eich,1982). The third action, CLARIFY, works on quite a different principle from REFLECT. CLARIFY attempts to select the specific affect label, i.e., "anger", "anxiety", etc., implied by the client's recent (and vague in terms of the exact underlying emotion) affect indicators. Each affect indicator implies a number of affects. In CLARIFY's prescription, the last three affect indicators are considered and the three fuzzy-sets of affects associated with each indicator are

intersected. If the affect in the intersection with the highest membership grade has a grade higher then a predetermined standard, then that affect is used in the response to the client.

Table 2.3 presents an example of a simple control structure. The structure contains strategic information which specifies when to use a particular action. The information is given in a production system--a list of "if-then rules" for the conditions under which actions are taken. The prouctions have the form " If 'P' then 'A'." "P" is a proposition which can be evaluated as true or false given the current state of the microworld. "P" is also a sentence in the formal language. "A" is an imperative to carry out an action for which there is a prescription in the knowledge base. (In Table 2.2 the prescriptions were presented separately from the productions for simplicity and because there may be a variety of conditions calling for the same action.) The system in Table 2.3 represents a very simple-minded counselor. The interpreter, in this case, would start at the top of the list and take the first production whose condition was satisfied, attempt to execute the action, and if successful, would go to the top of the list to select another action when one was needed. If the action could not be carried out, the interpreter would descend to the next production in the list.

The interpreter, even in the simplest situation, has several major functions to perform. It must:

1) Read in the knowledge base (as described above) from a text file.

2) Accept from the client a sentence which is legal in the formal language.

3) Change the stored representation of the counseling microworld by selecting one or more actions.

4) Select a terminal action for the current exchange with the client, i.e., a communication to the client.

After completing these tasks, the interpreter is then ready to accept a new sentence from the client. (The client response could

be provided by a client model similar to the one described in Hummel, Lichtenberg and Shaffer [1975].)

For the interpreter to operate, it must have a set of "primitives", .ie., words, categories, phrases, preprogrammed algorithms, and a grammar for constructing basic sentences. Part of the formal language, therefore, would already be in the system so that the user would have a base to start with in developing the language further. Some examples of preprogrammed procedures were implicit in the previously defined tables in that the interpreter had to be able to keep track of "time" and keep track of and manipulate recent statements made by client. Further, it had to have a limited ability to make inferences based on what was said by the client.

In designing the interpreter, one has flexibility in deciding how many of the actual counseling actions (as opposed to more generic information processes) would be built into the interpreter, as opposed to defining them in the knowledge base. Since the purpose of the system is to be instructional for a counseling intervention, both for the institution exporting the research and the institution receiving it, one might want to place as much counseling information as possible in the knowledge base.

In the preceding pages, an attempt has been made to present the benefits that would accrue from and the tasks involved in taking a more formal approach to the structuring and communicating of counseling knowledge. As other disciplines have discovered, particularly those in the physical sciences, having a formal language available is absolutely essential for clear communication, and it has been argued above that the same is true for counseling. When we can communicate our "treatment designs" as explicitly as our "experimental designs", there will be opportunities for more exacting replications of experiments. This is a prerequisite to an essential step in making systematic progess, for it leads to the goal of carefully building on past research.

TABLE 2.1

Knowledge Base: Examples of Factual Statements *

<HUMAN-OBJECTS>, <EMOTIONAL-STATES>, . . . ARE SETS.

"client" IS A HUMAN-OBJECT.

HUMAN-OBJECT IS AN OBJECT.

"counselor" IS AN AGENT.

"clarifies," "reflects," "restates,"NOD-AND-SAY 'Um-Hmm'" ARE ACTIONS

"angry," "anxious," "frustrated," "all-wound-up-inside," (etc.) ARE EMOTIONAL-STATES.

"confused," "attending," "not-confused" ARE <MENTAL STATES>

MENTAL STATES IS A SET.

EMOTIONAL-STATES AND MENTAL-STATES ARE STATES.

"healthy," "ill" ARE <PHYSICAL-ATTRIBUTES>.

"dishonest," "trustworthy," "dependent" ARE <CHARACTER-ATTRIBUTES>.

PHYSICAL-ATTRIBUTES, MENTAL-ATTRIBUTES ARE ATTRIBUTES.

<FRUSTRATION-INDICATORS>,<ANXIETY-INDICATORS> ARE FUZZY-SETS.

all-wound-up-inside HAS DEGREE-OF-MEMBERSHIP .5 IN FRUSTRATION-INDICATORS.

all-wound-up-inside HAS DEGREE-OF-MEMBERSHIP .6 IN ANXIETY-INDICATORS.

* Enclosing a word in quotation marks (" ") indicates that it is user-provided and new to the vocabulary of terminal symbols. Words enclosed in < and> are user-provided and new to the vocabulary of non-terminal symbols. Words enclosed in neither are words provided by the system.

TABLE 2.2

Knowledge Base: Examples of Prescriptions

PRESCRIPTION FOR RESTATE:

MAKE THE LAST-CLIENT-AFFECT-INDICATOR THE SELECTED-AFFECT-INDICATOR AND USE RESTATE.

PRESCRIPTION FOR REFLECT:

1. SELECT THE AFFECT-INDICATOR MOST SIMILAR TO THE LAST-CLIENT-AFFECT-INDICATOR IN TERMS OF THE DIMENSIONS-OF-AFFECT INDICATORS AND MAKE THE RESULT THE SELECTED-AFFECT-INDICATOR.

2. IF THE DEGREE-OF-SIMILARITY BETWEEN THE SELECTED-AFFECT-INDICATOR AND THE LAST-CLIENT-AFFECT-INDICATOR IS GREATER-THAN THE SIMILARITY-STANDARD, THEN REFLECT.

PRESCRIPTION FOR CLARIFY:

1. COMPARE THE CLIENT'S LAST THREE AFFECT-INDICATORS IN TERMS OF THE AFFECTS-IMPLIED.

2. SELECT THE AFFECT-IMPLIED IN THE RESULTS OF 1. WITH THE HIGHEST DEGREE-OF-MEMBERSHIP IN THE RESULT.

3. IF THE DEGREE-OF-MEMBERSHIP IS GREATER-THAN THE AFFECT-MEMBERSHIP-STANDARD, THEN CLARIFY.

TABLE 2.3

Knowledge Base: An Example of a Production System Type Control Structure for Selecting Actions

1. IF THE LAST-CLIENT-STATEMENT IS THE FIRST OR SECOND CLIENT-STATEMENT THEN USE NOD-AND-SAY "UM-HMM."

2. IF THE LAST-CLIENT-STATEMENT CONTAINS AN AFFECT-INDICATOR, THEN CLARIFY.

3. IF THE LAST-CLIENT-STATEMENT CONTAINS AN AFFECT-INDICATOR AND CLARIFY HAS NOT SUCCEEDED, THEN REFLECT.

4. IF THE LAST-CLIENT-STATEMENT CONTAINS AN AFFECT-INDICATOR AND CLARIFY AND REFLECT HAVE NOT SUCCEEDED, THEN RESTATE.

5. IF THE LAST-CLIENT-STATEMENT DOES NOT CONTAIN AN AFFECT-INDICATOR, THEN NOD-AND-SAY "UM-HMM."

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